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RECONCILING MODELS AND EVERYDAY LIFE

By Dr. Pierre St-Laurent, VIMS/CCPO Research Scientist

A benefit of being a modeler of the Chesapeake Bay living in Hampton Roads is that I get to see the regions represented by the model in my everyday life. A case in point is driving down Route 17 and crossing the 27 m-high George Coleman Memorial Bridge. It provides a beautiful view of the York River at the spot where it drains into the southern Chesapeake Bay. If one is crossing during the right phase of the tide, the flow of brackish water produces a clear contrast with the saltier water of the southern Bay accompanied by small-scale flow structures. As I drive across the bridge, I often wonder, "How large are these features? Are they captured by our numerical model? If they aren't, what are the implications for the physics and biogeochemistry of the model?" Reconciling numerical models with our everyday experience isn't always easy.

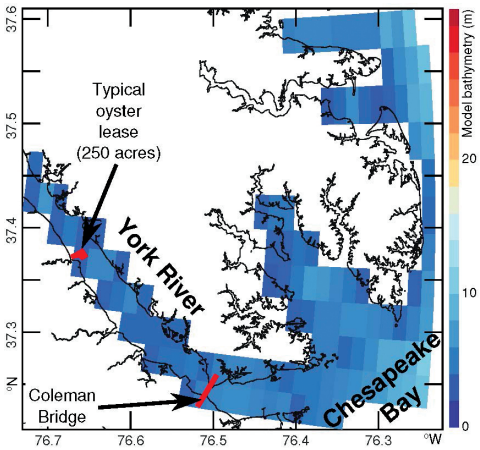

Figure 1. Bathymetry of the legacy Chesapeake Bay model in the vicinity of the York River.

Another example of this challenge comes from a project on oyster aquaculture and its vulnerability to ocean acidification. Many oyster hatcheries monitor local water quality conditions, but these measurements lack the temporal and spatial coverage necessary to understand the cause of their variations. Our role in the project is to address this difficulty by using a model of the Chesapeake Bay. While our legacy coarse-resolution model already provided an accurate description of the Bay's main stem, in tributaries, such as the York River, there remained a mismatch of spatial scales that limited the model's relevance. A typical oyster lease is 250 acres, which can be compared with the mesh size of the legacy Chesapeake Bay model (approximately 1 km by 1 km; see Fig. 1).

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OLD DOMINION UNIVERSITY

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Larry Atkinson, the founding director of CCPO, died December 22, 2020 at the age of 79 after an extended struggle with cancer. More details are provided on page 6.

MODELS | Cont.

To address this issue, my collaborator at VIMS, Marjorie A.M. Friedrichs, and I have developed over the last two years higher resolution implementations of the Chesapeake Bay model that take advantage of ever-expanding computational resources. The legacy Bay model is thus being replaced by a 600 m-resolution grid that includes wetting-drying and dynamic sediment transport. In turn, the 600 m grid provides highly realistic lateral boundary conditions to an even finer (120 m) grid that encompasses the York and Rappahannock Rivers. The 120 m grid explicitly resolves the type of fronts and filaments (Fig. 2) apparent to drivers on the Coleman Bridge and visible in aerial pictures taken by the harmful algal blooms monitoring program. More importantly, the 120 m grid resolves horizontal variations at the scale of individual oyster leases (Fig.2) and provides information relevant to hatchery operators.

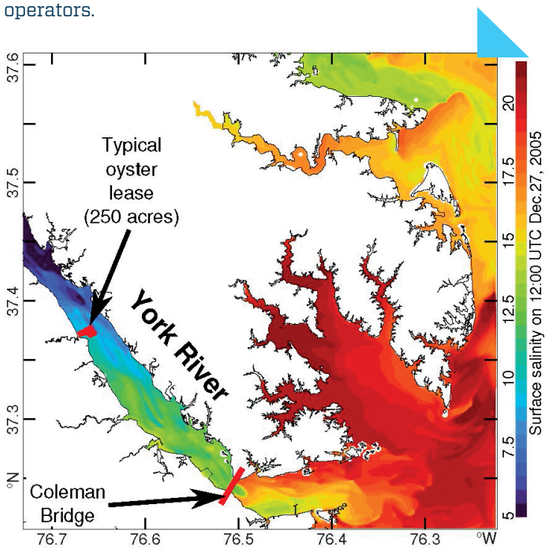


Figure 2. Snapshot of surface salinity from the 120 m-resolution model of the York River.

Some interesting lessons came out from this model improvement exercise. A common metric of hypoxia in the Bay is the annual hypoxic volume (in km^3 days), essentially a time- and space-integration of the regions of the Bay where dissolved oxygen is below a given threshold. To my surprise, the year-to-year variability of this model metric proved to be largely insensitive to the grid improvements. In hindsight, such an integrative metric mostly reflects the nutrient loadings from the Bay's watershed (that fuel the Bay's hypoxia) and the wind conditions, both of these factors being the same in our coarse/high resolution simulations. On the other hand, the spatial distribution of the modeled hypoxia benefited tremendously from the improved grid resolution, allowing us to better address the needs of local stakeholders in the future.

CCPO'S EARLY CONNECTIONS WITH LATIN AMERICA

By Dr. Arnoldo Valle-Levinson,
University of Florida

My early professional, formative years occurred at CCPO, where I arrived immediately after obtaining my Ph.D. degree. At the time, my main research focus was on estuarine hydrodynamics, mostly in temperate climates. **Larry Atkinson**, the founding director of CCPO, sparked a series of collaborations in Latin America. It all began through connections with Chilean colleagues in the middle of the 1990s. Collaborations required interdisciplinary approaches to understand larvae transport, nutrient and dissolved oxygen budgets, and the ecosystem impact of aquaculture activities. Cooperative endeavors translated into field work in fjords and in the coastal regions of central Chile. Chilean field work ignited my affinity for on-going studies of fjords and bays. Collaborations also became workshops and short courses throughout the Andean country. The same type of pursuits soon extended into Mexico's vast geography, triggering my attraction to coastal lagoon studies. Field work, workshops, and short courses in Chile and Mexico, and later Argentina, provided fabulous connections to an enthusiastic group of students and collaborators with brilliant ideas. Durable interactions were facilitated by eager and collegial attitudes. Happily, some of the participating students and collaborators became graduate students at CCPO. Other participants visited CCPO for weeks or months. Unquestionably, these exchanges promoted steady and fruitful cooperative pursuits that persist.

After moving to Florida from Virginia, I was introduced to subtropical environments. The karst topography, the seasonality in explosive atmospheric forcing and the state's vulnerability to sea-level rise presented new research topics and international collaborative opportunities. Further Latin American connections have developed in Brazil, Colombia, Costa Rica, Panama, and Mexico. All of these collaborations have had a focus in coastal tropical environments, whose dynamics have been understudied. Some of the professional exchanges with Latin American scientists and students have even allowed them to expand their reach to multiple institutions in the USA and worldwide. Such a network of common interests has promoted the participation of Latin American scientists and students in far- and wide-reaching projects in the USA. The network has also resulted in a non-affiliated group that organizes biennial meetings on the Latin American Physics of Estuaries and Coastal Oceans (LAPECO). The next LAPECO meeting is scheduled to take place in Panama City, Panama in October 2021.

In recent years, my estuarine and fjord hydrodynamics research focus has expanded to other areas. Tropical and subtropical regions are natural laboratories to investigate storm surge-tide interactions, meteotsunamis, compound flooding, sea-level changes, and saltwater intrusion into estuaries and aquifers. All of these phenomena directly affect coastal populations, ecosystems, and economies. My recent investigations on sea-level changes in the last 120 years have suggested a linkage to lunar orbital cycles (lunar precessions of 18.6 and 8.85 years) and to solar activity (sunspots with periodicities between 10 and 11.5 years). These periodicities and some interactions or modulations among them explain more than 75% of the variance of >5-yr sea-level oscillations in eastern USA and in the Adriatic Sea, suggesting the possible influence of predictable astronomical forcing.

The linkage of last-century sea-level variations and astronomic forcing is a promising finding that may help prepare coastal communities for periods of higher-than-normal baseline sea levels. For this finding, I had to consider astronomy concepts related to various lunar cycles and explore dendrochronological studies that have suggested relationships among climate indices, such as ENSO and PDO, to lunar and solar variations with periods >5 yrs. In fact, because of the dendrochronological studies identifying lunar periodicities in ENSO and PDO proxies, I have explored the potential connection of lunar and solar periodicities to the ENSO signal. If there is indeed a connection, then we should be able to propose that ENSO variability is not only related to the internal variability of the ocean-atmosphere system but also to astronomical forcing. In all of my research and collaborations, there is a touch of Larry Atkinson's influence. I owe him an immense debt of gratitude for his mentorship throughout the 12+ years of my stay at CCPO. I want to honor Larry here and express my deepest appreciation for his selfless, enthusiastic, and unlimited guidance.

Velocity measurements being collected with a towed ADCP at a Patagonian fjord off the Strait of Magellan.

Velocity measurements being collected with a towed ADCP at a point source of submarine groundwater discharge off the northern coast of the Yucatan Peninsula.

CCPO Alumni Spotlight

ANDREA PIÑONES, M.S. '06, PH.D. '11

I arrived in the United States and CCPO in August 2004 and stayed during 10 years for my graduate studies and post-doctoral training. I'm a Chilean citizen and I currently live in Chile. I received a bachelor's degree in Oceanography in my home country at the Catholic University of Valparaíso, a beautiful, energetic and colorful, coastal city. Afterward, I moved to a small town farther south and worked as a research assistant in the ECIM (Estación Costera de Investigaciones Marinas) Marine Laboratory off the coast. There, I had the opportunity to work and collaborate with former CCPO professor, Dr. Arnoldo Valle-Levinson, who encouraged me to apply to the oceanography graduate program at ODU. So, I did and that is how I began my journey at CCPO and graduate school. When I arrived, everyone was very friendly, and, as an international student, I felt supported and respected. By that time, there was a large group of international students at CCPO, so this was a great opportunity to meet the world in just one place. I don't know if it is only my impression, but we spent most of our free time around barbeque and international dishes, and with that international crowd, I assure one never felt hungry.

For the first two years, I worked on my master's project that looked at the importance of tidal forcing in the circulation of Chesapeake Bay. Although the project did not include active sampling mostly because the data was already obtained in previous years, I still had the opportunity to participate in short-term cruises on the lower Chesapeake Bay with an outreach program that would involve high school teachers and students doing oceanography sampling in the lower Bay. That was one of the first experiences I had as a grad student to communicate science in a different way. During my master's studies, I also had the great opportunity to work and collaborate with and be mentored by **Larry Atkinson**. I will always be grateful to him for sharing his knowledge and wisdom and making us feel welcomed and part of the CCPO family. We will surely miss him very much.

Andrea, on board the RV *Karpuj* in Maxwell Bay (Antarctica), participated in sampling, measuring of ocean currents, and conducting of CTD profiles during January 2020.

While I was finishing my master's thesis, there was an open position for continuing on with Ph.D. studies, working in a very different region and topic—one that involved the Southern Ocean. At first, I was not sure what that meant, for me as a Chilean, I was already in a "southern" ocean, but when the word *Antarctica* was mentioned, I knew that was my path. I started my Ph.D. in 2006 under the guidance of **Eileen Hofmann** and co-guidance of **John Klinck**. My Ph.D. dissertation was part of the Southern Ocean GLOBEC program, an interdisciplinary research program that focused on understanding the environment and life history of a keystone species, Antarctic krill, along the western Antarctic Peninsula. Until that moment, I did not know what it was to work in an interdisciplinary group, and it was a science changing experience. I remembered feeling so nervous in the first group meetings, but thanks to those opportunities, I learned the value of sharing and collaboration, some professional training that is crucial for what I have to do now as a leader in different academic and research tasks I take on every day. I am very thankful to Eileen and John for giving me the opportunity to be part of the SO GLOBEC program, as I visited Antarctica once and participated and national and international meetings that shaped my scientific career. During all the meetings and travels, I met passionate Antarctic early career scientists who now are my colleagues and collaborators.

After graduating in December 2011, I stayed for one year at CCPO and worked as a postdoctoral researcher on a project in the Ross Sea that involved ocean modeling and observations of the circulation using autonomous ocean gliders. At the end of 2012, I was awarded the Yale Climate and Energy Institute postdoctoral fellowship at Yale University to study the impact of climate change in the habitat of Antarctic krill. So, I moved to New Haven, CT and stayed there for two years. After 10 years in the USA, I was ready to return home and contribute to our national science, so I applied to and was funded for a postdoctoral fellowship to continue studying ocean circulation-ecosystem interactions along the Antarctic Peninsula. Parallel to this, we (Chilean scientists) were funded to create the first National Research Center (IDEAL Center, www.ideal-center.cl) that will focus only on understanding the impacts of global change on the Patagonian and Antarctic marine ecosystems. This research center was funded for five years and has recently been extended for another five years. Great science and collaborations have continued throughout the years since my graduate studies at CCPO, with Eileen, John, and **Mike Dinniman** actively working and collaborating with us on studies undertaken by the IDEAL Center.

In 2017, I was appointed assistant professor in the Institute of Marine and Limnological Science at the Austral University of Chile, located in Valdivia. As one of the most beautiful Chilean cities, it reminds me a lot of Norfolk and the Hampton Roads area, surrounded by rivers and close to the ocean. I cannot believe that more than 15 years have already passed since my arrival at CCPO. I keep great memories of all the friends and colleagues at CCPO. Best regards to you all.

CCPO Alumni Spotlight

ANDRÉS SEPULVEDA, PH.D. '04

As I've been told, it all started with a plane delay in the early-mid 1990s. A Chilean researcher, Victor Marin, had to stay longer at CCPO during a visit to the US. While waiting, he browsed over some SST satellite images on one of the computers and this led to a talk with **Larry Atkinson**, CCPO Director at that time, and the beginning of a collaboration. I did my undergrad in Physics at the University of Chile, in Santiago, where I took a course in Antarctic Oceanography taught by Victor Marin. Later, while registering for a course in Atmospheric Chemistry, another teacher, Vivian Montecino, noticed my interest in something beyond equations and invited me to her lab to work with them on their studies of UV light effect on marine primary productivity. My first job was to do least squares regressions to the Lambert-Beer law. I felt like a lucky charm, to be used against equations and math by my biological oceanography colleagues.

Then a friend fell ill before a cruise and my first chance to go on board a research cruise materialized in 1994 by joining the AGOR *Vidal Gormaz*, the scientific ship of the Chilean Navy that participated in a JGOFS expedition.

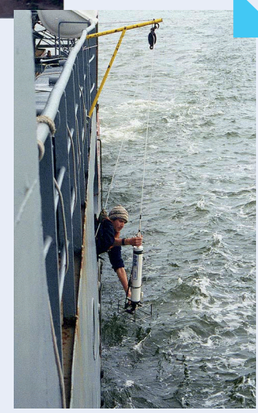
Top: Andrés in Dichato, Chile, attending a summer numerical modeling course.

Sometime later, CCPO researcher, Arnoldo Valle-Levinson, and Atkinson came to Chile and we met for the first time in Montecino's lab. By that time, I had moved to Marin's lab and had my first struggles with numerical models of the ocean, learning to use the Princeton Ocean Model (POM). A colleague, Jorge Mesias, advised that one should know the code of the model by heart, as if it were a poem. Luckily at that time, POM was just a single, long file. We came to realize that I needed further training, and Victor Marin coordinated a two-month stage at CCPO for a colleague and myself. Once there, I felt it was the right place to study and the application process began. Finally, in September 1997, life as a student at CCPO started.

I have great memories of my time as a Ph.D. student there, mostly by the friendship that developed with other students like Hae-Cheol Kim, Bettina Fach (my officemate of many years), Isaac Schroeder, Nandita Sarkar, and the Valle-Levinson research group: Rosario Sanay, Cristobal Reyes, and others. Most of that time was devoted to the obscure arts of ADCP measurements. We developed a vast experience in how to make our standard 24-hour repeated track on short notice, anywhere in the world. The field work was amazing and took us to Chile, Argentina (my first paper, on the Rio de la Plata residual currents), and Central America. I also have to thank **Eileen Hofmann** and **John Klinck** for the chance to participate in a cruise to Antarctica on the RVIB *Nathaniel B. Palmer*. Life was good and interesting at ODU. Instigated by Lorraine Heilman, Valle-Levinson's research associate at that time, I joined ODU's martial arts program, managing to learn a bit of Aikido along the way. It was good to have some activities outside of Crittenton Hall, CCPO's first home.

When it was time to think about graduating, I decided to hone my skills in the use of numerical models, improved by Klinck's classes, just in case it would get hard to secure funding back in Chile (oh boy, was I right). For that, I spent a couple of months at Dalhousie University working with Keith Thompson, an expert on data assimilation, and thinking this could be a good way to combine my experience in field work and numerical models. Long story short, this is my life now. As a postdoc, I spent a year at WHOI learning FVCOM with Bob Beardsley's group before finding a position at the University of Concepción in Chile, where there were many excellent ocean-going oceanographers but few (one then) numerical modelers. In the Geophysics Department of the University of Concepción, I work on numerical models of the ocean (currents, waves) and the atmosphere (using WRF). The poor guys here have an oceanographer teaching atmospheric modeling, but hey, it is a small group. They even once elected me as department chair, but in retrospective, it was more of a punishment than a recognition. For the first few years, my academic collaborations switched to Europe—France in particular. It helps that my wife, whom I met at ODU, is French, so travels to visit colleagues also included a few more days to visit relatives. Going full circle in many ways, recently there have been a few, unfunded opportunities to work again with Klinck and **Mike Dinniman** in Antarctic oceanography. I hope these develop further, as it would be great to visit CCPO again in its new home and share stories with old friends and new students.

Below: Andrés assisting with measurements being done in the Rio de la Plata Estuary, as part of an international US-Argentina project.



LARRY P. ATKINSON
1941–2020

We are sad to report that **Larry Atkinson**, the founding director of CCPO, died December 22, 2020 at the age of 79 after an extended struggle with cancer.

The summer edition of the CCPO newsletter will be dedicated to Larry Atkinson. We encourage anyone with a story involving Larry to submit it to **newsletter@ccpo.odu.edu.** We will collect these contributions and include as many as possible in the next newsletter.

We are working with the ODU Office of Development to establish a Larry Atkinson Scholarship Fund that will be used to support undergraduate and graduate students. Larry enjoyed working with students and providing them with access to a range of exciting research opportunities. This scholarship fund will continue Larry's legacy in educating students in ocean science. Information about how to make contributions to the scholarship fund will be posted on the CCPO web site and provided in the next newsletter. Please send any inquiries to **newsletter@ccpo.odu.edu.**

Letter from the Director

I am continually impressed at the international connections that were developed and continue to this day by faculty, postdocs, and students at CCPO. We see in this newsletter a continuing connection with scientists in Chile. Much of the credit for this connection is due to **Larry Atkinson**, Arnoldo Valle-Levinson, and Jose Blanco. Soon after joining CCPO, Arnoldo collaborated with Larry to develop projects focused on studies of the fjords in southern Chile. These projects included Chilean scientists and a major benefit of these collaborations, especially through Arnoldo's efforts, was that several Chilean students enrolled in the oceanography graduate program at ODU and worked with CCPO scientists on M.S. and Ph.D. degrees. Several of these graduate students are now faculty members at universities in Chile.

Through these personal connections, **Eileen Hofmann** developed a collaboration with some of the former CCPO students and other scientists in Chile to implement a series of workshops for graduate students in Chile and other countries in South America to teach numerical modeling techniques applied to marine ecosystems. Graduate students from Chile continue to be attracted to ODU as part of this collaboration.

The numerical modeling workshops were scheduled to continue for several years but have been interrupted by travel restrictions created by the Covid-19 pandemic. As the scientific world attempts to restart its previous activities (travel, workshops, scientific meetings, etc.), we hope to continue with this international collaboration and expand this activity to more universities in Chile.

— Dr. John Klinck, Director of CCPO & Professor of Oceanography

JUST THE FACTS

Accolades

The following CCPO faculty were included in the Stanford University World's Top 2% of Scientists 2020, which recognizes the top 2% of the most-cited scientists in various disciplines:

G.T. Csanady (retired), T. Ezer, A. Gargett (retired), T. Gatski (retired), E.E. Hofmann, and J.M. Klinck.

Publications

Hart, D.R., D.M. Munroe, J.C. Caracappa, D. Haidvogel, B.V. Shank, D.B. Rudders, **J.M. Klinck, E.E. Hofmann**, and E.N. Powell. 2020. Spillover of sea scallops from rotational closures in the Mid-Atlantic Bight (United States), *ICES Journal of Marine Science*, 77(5), 1992–2002, https://doi.org/10.1093/icesjms/fsaa099.

Kumar, P., B. Hamlington, S.-H. Cheon, W. Han, and P. Thompson. 2020. 20th Century Multivariate Indian Ocean Regional Sea Level Reconstruction, *Journal of Geophysical Research: Oceans*, 125, e2020JC016270. https://doi.org/10.1029/2020JC016270.

Plag, H.-P., 2020. Changing Global Risk perception – Learning what is needed to increase community resilience from the "stress test" pandemic, Column 22 in "On The Edge", *ApoGeoSpatial*, 35(1), 12-15.

Plag, H.-P., 2020. Modern Climate Change: A Symptom of a Single-Species, high energy pulse, Miller, D. E. and B. Eggleston (eds.), Moral Theory and Climate Change: Ethical Perspectives on a Warming Planet, Taylor and Francis/Routledge, pp. 6-34.

Roarty, H., S. Glenn, J. Brodie, L. Nazzaro, M. Smith, E. Handel, J. Kohut, **T. Updyke, L. Atkinson**, W. Boicourt, and W. Brown. 2020. Annual and Seasonal Surface Circulation over the Mid Atlantic Bight Continental Shelf Derived from a Decade of High Frequency Radar Observations, *Journal of Geophysical Research: Oceans*, 125(11), https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020JC016368.

Salmon, E., **E.E. Hofmann**, **M.S. Dinniman**, and W.O. Smith, Jr., 2020. Evaluation of Iron Sources in the Ross Sea, *Journal of Marine Systems*, 212, 103429, doi:10.1016/j.jmarsys.2020.103429.

Twigg, E., S. Roberts, and **E. Hofmann** (Guest Editors). 2020. Understanding the Effects of Offshore Wind Energy Development on Fisheries, *Oceanography*, 33(4).

Virtual Presentations

Buzzanga, B.A., Assessing the role of ICESat-2 in understanding Coastal Sea-Level (poster), 2020 AGU Fall Meeting, December 2020.

Dinniman, M., P. St-Laurent, K. Arrigo, **E. Hofmann**, and G. van Dijken. Sensitivity to changes in the winds of cryosphere contributions to micronutrient supply to the surface waters around Antarctica, 2020 West Antarctic Ice Sheet Workshop, September 2020.

Dinniman, M.S., P. St-Laurent, K.R. Arrigo, **E.E. Hofmann**, and G. van Dijken. Sensitivity to Changes in the Winds of Cryosphere Contributions to Micronutrient Supply to the Surface Waters around Antarctica, 2020 AGU Fall Meeting, December 2020.

Hofmann, E.E., Understanding Controls on *Margalefidinium polykrikoides* Blooms in the Lower Chesapeake Bay, Biology Department Virtual Seminar Series, East Carolina University, October 22, 2020.

Hofmann, E.E., Modeling Western Boundary Current Interactions: Approaches and Challenges, Western Boundary Current Shelf Symposium: Agulhas, Brazil, and Gulf Stream Currents Session 1, November 10, 2020.

Hofmann, E.E., Understanding Southern Ocean Ecosystems and Global Connectivity: Approaches and Challenges, Oceanographic Society of Japan, Young Scientists Virtual Seminar Series, November 23, 2020.

Hofmann, E.E., Understanding Controls on *Margalefidinium polykrikoides* Blooms in the Lower Chesapeake Bay, virtual poster and eLightning presentation, 2020 AGU Fall Meeting, December 8, 2020.

Hudson, K., M.J. Oliver, J.T. Kohut, **M.S. Dinniman, J.M. Klinck**, H. Statscewich, K.S. Bernard, and W. Fraser. A Recirculating, Subsurface Eddy Increases Deep Resident Times in an Antarctic Biological Hotspot, 2020 Fall AGU Meeting, December 2020.

Plag, H.-P., Ethical challenges in adapting the urban coasts for the post-Holocene in times of Anthropocene risks, Invited presentation at 6th High-Level Industry-Science-Government Dialogue on Atlantic Interactions: All-Atlantic Summit on Innovation for Sustainable Marine Development and the Blue Economy: Fostering Global Economic Recovery in a Post-pandemic World, October 7, 2020.

Plag, H., and B. Clemson. Monitoring the Health of Riverine Systems, Invited presentation at the Metaphorum Webinar, November 11, 2020.

Plag, H.-P., and **D. Martin**. Facilitating citizen science projects embedded in communities through best practices for citizen scientist certification, Invited Presentation at the Evolving and Sustaining OBPS Workshop IV, September 22, 2020.

Plag, H.-P., and **D. Martin**. Knowledge needs, co-creation and co-usage of knowledge, Evolving and Sustaining OBPS Workshop IV, September 24, 2020.

Updyke, T.G., et al., Implementation of Real-Time Quality Control in the MARACOOS 6-Kilometer Surface Current Product (poster), Radio-wave Operators Working Group Virtual Conference, November 2020.

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Center For Coastal Physical Oceanography (CCPO) and Institute for Coastal Adaptation & Resilience (ICAR) Virtual Seminar Series

SPRING 2021 SCHEDULE

1 February	**Philip Berke**, *University of North Carolina at Chapel Hill*
8 February	**Taylor Sloey**, *Department of Biological Sciences, ODU*
22 February	**Natalie Robinson**, *National Institute for Water and Atmospheric Research, New Zealand*
1 March	**Janet Sprintall**, *Scripps Institution of Oceanography*
8 March	**Thomas Wahl**, *University of Central Florida*
15 March	**Austin Becker**, *University of Rhode Island*
22 March	**A.R. Siders**, *University of Delaware*
29 March	**Hans Louis-Charles**, *Virginia Commonwealth University*
5 April	**Ray Toll and Laura Rogers**, *OCEANS 2022*

MONDAYS at 3:30 PM EST

Streaming at:
www.ccpo.odu.edu/seminar.html

https://odu.zoom.us/j/98919203900?pwd=MzZwSW1Ca2OwUzFpZ1AzSjZudW1CZz09

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